exceeds both the cost of subsidies and the pecuniary evaluation of the inefficiencies resulting when subsidized bidders win.

16. Small firms' purposes in entering the WCS auction are primarily pursuit of "in-use values" through innovative technologies. A rational speculator will find bidding in the WCS auction likely a less profitable option than injecting equity into a firm with negligible prior CMRS presence who won some D, E, F block licenses.

Below, after explaining the points just itemized in part I, I will turn my attention in part II to the implications for how the WCS auction should be conducted, as logical conclusions from an appropriate understanding of efficiency. These are:

17. Fighting warehousing of spectrum for anti-competitive purposed must be the FCC's highest priority.

18. The increased potential for warehousing has made the 45 MHz spectrum cap much more important than before. Indeed, the FCC should attempt to prevent CMRS incumbents with effective capacity from obtaining any further spectrum.

19. Since warehousing by incumbents is one identifiable usage of spectrum that *a fortiori* has less social value than any other, the FCC should consider license-specific bidding credits for non-incumbents.

20. Efficiency suggests that as small license areas as possible be auctioned, to allow efficient usage is as wide as possible a set of technologies. Given the 30G-licenses constraint, this argues for offering 3 paired channels of 5 MHz each direction in each MTA.

21. The 153 licenses this implies will not create time difficulties. It does not mean processing anywhere near 153 payments: The experience of broadband auctions has been a concentration of licenses in a few firms.

22. Bidding credits of effective magnitude for small firms are essential to the hope for an efficient outcome. A small firm which purchased spectrum at the same price as a large firm would face a daunting disadvantage due to higher capital costs.

23. Since the Congressional mandate to collect payments by Sept. 30, 1997 prevents deferred payments, and deferred payments were a larger advantage for small businesses than bidding credits in C-block auctions, bidding credits substantially above those in the C block are called for.

24. Efficiency calls for splitting the 30 MHz in ways compatible with as many technologies as possible: DARS, low-tier microcellular technologies, such as PACS, and others.

25. Firms using low-tier microcellular technology, such as PACS, need paired channels. Simply breaking into 5 MHz segments would yield a very serious inefficiency: a warehouse could tie up 10 MHz of spectrum while only buying 5 MHz.

26. The extent of buildout which an efficient social planner would prefer varies substantially across the various technologies we know are vying for WCS spectrum. No build out requirements will accommodate them all.

27. Buildout requirements on blocks A-F ensure that primary spectrum uses are extended adequately to rural customers.

The third part of the brief points out that changes in the rules out to be limited to those that do not change fundamental incentives of the current auction form. The Congressional time constraints are an insurmountable enemy of reasoned experimentation:

28. Significant changes in the form of the auction are unwise, and unneeded; there are tools the FCC can use more effectively within the current form to control the length of time the auction takes.

29. The current auction form is known to work, which cannot be said of alternatives available then or suggested now.

30. The FCC can speed up the auction by using more rounds per day, effectively, so long as the schedule is known, fixed, and unrelenting.

31. Minimum bid increments can be used much more effectively than in recent auctions to speed up conclusion.

32. A procedure is provided whereby the FCC can systematically end the auction within little over a day, without introducing the sort of inefficiencies that a single, first-price-like, final round would cause.

The fourth part deals with the most important use of the Congressionally limited time:

33. Congress has applied tight time pressure. The most important phase to resist shortening is the time from finalizing rules to requiring upfront payments.

34. There is plenty of time to announce final rules, still give firms enough time to get their funding arrangements settled, and finish the auction on time.

Part I: Interpreting Efficiency

1. Efficiency, meaning allocative efficiency, *is* in principle well-defined: an allocation of resources to households, to firms owned by households, and to public-sector agencies with well-defined resource-requirement tradeoffs, is efficient if there is no other allocation that would universally be preferred.

This definition *is* essentially useless outside theoretical models. So economists typically ignore possibly significant complications by assuming that an allocation can be considered efficient if it maximizes the sum of producers' and consumers' surplus. This definition is, however, only a step toward being operational.

Most auction theory papers, in a trend echoed by the FCC,[1] leap to a much stronger simplification: they assume that efficiency means awarding licenses to the bidders willing to pay the most for them.

With market concentration in any of the main affected markets, this simplification is never true. It was arguably an acceptable approximation at the time of adoption of the broadband auction rules, but only for two reasons: [i] cellular incumbents in an MTA were barred from bidding for 30 MHz PCS licenses, [ii] there were no PCS incumbents.

At the conclusion of the D, E, F block auction, there will be 5 to 8 CMRS incumbents in every market. Cellular and PCS incumbents have far different incentives in bidding for WCS licenses. Let us revert to the less heroic sum-of-surpluses measure and consider the relevant comparisons:

Scenario G (for "Good"): A firm with at most negligible current spectrum holdings wins a WCS license. It uses the spectrum to offer a new and innovative product. Due to limited price

[1] *Second Report and Order*, and this NPRM 96-441 at 18.

discrimination opportunities, most customers were willing to pay more for the class of service received than the price charges. Hence, both consumers' and producers' surplus increase.

Scenario NG ("Not Good") A firm with 30 or more MHz in an MTA wins a WCS license, to add to its spectrum capacity. It realizes that any new service offerings would be risky and would steal at least as many customers from its current offerings as from those of its current competitors. So, as anticipated before it bid, the firm simply adds the new spectrum to its capacity, and continues its present market offerings. The extra capacity *is* not really needed; it *is* being "warehoused" to prevent a firm that might have obtained that spectrum from entering the CMRS market.

The impact of warehousing is to keep prices, and therefore profits, higher than they would have been. Since prices after entry would still be above marginal costs, the increase in producers' surplus that results from warehousing is necessarily smaller than the decrease in consumers' surplus that results. As with a variety of exercises of market power, warehousing of spectrum is necessarily inefficient.

2. A WCS license winner becoming a new entrant in a CMRS market is vastly preferable to warehousing, but honestly accomplishes little in the way of effective increase in competitiveness. If there is no overlap in the cellular incumbents and the A-F block winners, the WCS license holder becomes potentially the 9th firm in the CMRS market, in addition to any SMR competitors. The WCS firm would be wildly optimistic, given last-mover disadvantages, to expect as large as a 10% market share. None of the several serious business analyses I have seen or learned about have pegged the break-even market share nearly as low as 10%. A WCS entrant that cannot reach break-even market share cannot have any lasting favorable impact on prices.

If there are fewer CMRS competitors, that will be because one or more of those firms decided it would be a stronger competitor with more capacity. That would be worse news for a WCS entrant.

3. The situation in the local exchange market is vastly different. Increased wireless market penetration has been almost exclusively customers adding communications services, with very little revenue loss to the LEC. The LEC has near-monopoly market power, subject only to approval from often ineffective regulatory agencies.[2]

We have just begun to see what appears to be substantial entry into retail telephone service markets. To the extent that consumers find some value in "one-stop shopping," the LEC does face the prospect of some loss of local exchange revenue. However, this does not lead to a loss of LEC market power. As the "one-stop shopping" firms are resellers of the LEC's local loop, the LEC will have just as much control over the pattern of local phone rates, via coordinated changes in its retail rates and its access charges.

4. *The WCS auction might present an opportunity to introduce some real competitiveness to the local exchange market.* Should a firm planning to introduce a low-tier microcellular technology, such as PACS, win a WCS license, it can create a higher impact entry into local exchange (as well as competing in the CMRS market). Since low-tier microcellular technologies, such as PACS, offer landline sound quality, such firms can enter local exchange without being resellers of the local loop. Specifically, a PACS firm will not resell both

[2] Such oversight has historically been ineffectual in the sense of failing to increase consumers' surplus over levels expected with unregulated monopoly.

origination and termination on any local call. If the access charge per call for the PACS firm to terminate via the local loop is the same as the access charge per call for the LEC to terminate via a PACS connection, then under weak assumptions, the access charge payments flowing from the PACS firm to the LEC will total approximately the same as the access charges flowing the reverse direction.

Thus an entrant using low-tier microcellular technology, such as PACS, notably reduces LEC market power. Appendix I offers examples of impact on Herfindahl-Hirschman Indices (HHI). Use of WCS spectrum creates very little reduction in HHIs for traditional high-tier CMRS markets, which are already rather low. Indeed, removal of the 45 MHz spectrum cap makes it very likely that HHIs will show greater market concentration after the WCS auction than before. In contrast, PACS entry into local exchange with a WCS license dramatically reduces an HHI that begins very high. This occurs even under very conservative assumptions about the market share the PACS firm can attain. Straightforward calculations show that the LEC will most profitably leave its prices unchanged even when undercutting by the PACS firm shifts numerous customers.

There is no single, universally accepted method for comparing the importance of reducing on HHI in one market (local exchange) from over 9,000 to around 6,000 to reducing an HHI in another market (CMRS) from perhaps 1,600 to 1,500. I use a simple measure designed to count more highly a given HHI reduction if the initial level showed more market concentration. *This implies that an entrant to local exchange who is not a reseller accomplishes an objective that is about* 18 *to* 125 *times as important as the greatest accomplishment that can be expected via WCS spectrum usage in CMRS markets.*

5. For WCS spectrum to be warehoused is sharply contrary to the Congressional mandate to attempt "the rapid deployment of new technologies, products and services." Warehousing is similarly adverse to "promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses owned by member of minority groups and women." No other imaginable use of spectrum could be more contrary to "efficient and intensive use of the electromagnetic spectrum."

6. The FCC originally decided to make A, B, and C block licenses 30 MHz each due to industry responses to the original NPRM. These responses showed a near consensus that potential bidders for the A and B Block auctions believed 30 MHz to provide sufficient capacity for a provider to attain a favorable market share even in the most densely populated urban areas.

That was three years ago. Market penetration since has been within usual confidence intervals of geometric expansion. In plain English, demand has grown, but not significantly more than expected. However, there have been major strides in data compression capabilities in the last three years; 30 MHz can provide a capacity today that is a substantial multiple of capacity then (details vary with technology; some have expanded capacity 5- to 7-fold, others up to 10-fold). So it is beyond the pale to claim that a PCS provider's legitimate capacity needs approach anywhere near 45 MHz.

Considerable equipment modification is needed for cellular providers to use spectrum as efficiently as PCS providers. Until equipment changeover is complete, cellular carriers could require slightly greater capacity than a PCS provider needs. However, until changeover is complete, cellular carriers will be at a legitimate disadvantage in attracting new customers, and

should expect market share diminution. In any event, it also stretches credibility to argue that a cellular carrier's legitimate capacity needs approach anywhere near 45 MHz.

In the near term, the natural and appropriate priority for a cellular incumbent or a PCS A, B, C winner is shoring up its base. For a PCS firm, this means reaching a rapid conclusion of build out, and then market entry. For a cellular incumbent, this means rapid equipment refitting and acquiring the added sites needed to offer digital communications. For either to argue that more spectrum is needed to bring to fore plans for innovative technologies and services, that could not be offered without additional spectrum, is not credible in the least.

Thus demand for more spectrum by a PCS carrier holding about 30 Mhz or more (or a cellular firm holding perhaps 35 Mhz or more) is compelling evidence of warehousing intent.[3]

7. Warehousing spectrum incurs a cost (purchase price) in order to attain higher prices than would otherwise prevail. As such, it is the exercise of a degree of monopoly power, rightly considered to constitute unjust enrichment. In this sense, then (considering point 5 above), all four Congressional objectives mandate the FCC to attempt to prevent warehousing. The "need to balance conflicting objectives" that some have claimed when lobbying the FCC does not arise here.

8. None of the standard industrial organization models of concentrated industries fit the critical features of the CMRS market perfectly. It is reasonable, though, to believe that characterizations common to all these models may well apply to this industry.

Such a feature is the robust phenomenon that the value to a monopolist of maintaining its monopoly status exceeds the profit an entrant could obtain. This feature follows whenever total industry profit in a duopoly is less than the profit a monopolist could attain. In the simplest example, firms selling identical products with identical costs and quantity-setting strategies (the "Cournot" model), a monopolist would always be willing to pay *25% more to warehouse* a single license and maintain monopoly than the *most* a potential entrant would be willing to pay for that license.[4]

Faced with these conclusions, a CMRS incumbent is likely to dispute the identical-products assumption of the Cournot model. But there is little solace for any other conclusion in models of concentrated industries with differentiated products. Several standard models lead to very similar conclusions.[5]

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[3] Warehousing may well occur at lower capacity levels, but arguments for needed capacity might be envisioned at levels significantly lower.

[4] Within the same model, suppose a CMRS market with 3 principal incumbents, and the other current providers doomed to insignificance. Further suppose that a potential entrant needs to acquire all three 10 MHz WCS licenses in this market to become a survivable threat to the three firms. Then, in equilibrium, each of the three firms is willing to pay up to 69% more for one of the 10 MHz licenses that the most any potential entrant could afford to pay.

[5] Suppose a CMRS entrant is deemed equally likely (or unlikely) to obtain customers from all incumbents. Then the most appropriate model is the Chamberlin model. It predicts the same results as the Cournot model above, only more striking: the percentages by which incumbents seeking to warehouse spectrum would be willing to outbid entrants are higher in the Chamberlin model.
The alternative assumption is that product differentiation takes the form of establishing market niches, and an entrant must find his own market niche. That is, the entrant will only take customers away from the "adjacent" incumbents—those who are targeting customers in a manner most similar to the approach which the entrant uses to differentiate his product. The basis model used to analyze such markets is called the "address" model (a nice exposition of all these models is in chapters 11 and 12 of Eaton and

I conclude that auction rules which make no attempt to prevent warehousing, beyond maintenance of the 45 MHz spectrum cap, are likely to yield the least efficient outcome *possible.* All the spectrum that cannot be put to uses unrelated to CMRS, at a risk-adjusted rate of return far in excess of that available in CMRS markets, is likely to be warehoused. All that will be accomplished is the prevention of entry into these markets, and movement toward *less* intensive use of the electromagnetic spectrum.

9. Several comments on auction NPRMs have pronounced any new and innovative technology plans by small firms to be necessarily inefficient uses of spectrum.[6] This leads them to claim that the objectives of making new technologies readily available and of achieving efficient spectrum usage are in conflict. An appropriate understanding of efficiency shows how transparently fallacious these pronouncements are. These goals are often harmonious; for one example, both objectives are served by attempts to avoid warehousing. A more direct example: given uniform prices or limited price discrimination, the profitable introduction of a new communications service via an innovative use of spectrum necessarily increases the producer's surplus reaped by its developer and also the consumers' surplus attained by its customers.

Considering the devastating consequences of warehousing, efficiency calls upon the FCC to accept the highest bid submitted by a firm intending an innovative use even when a rival bidder intending to warehouse the spectrum being licensed bids 50-100% higher.

10. The methods economists all too predominantly use to analyze microeconomic policy issues ignore the efficiency impacts of changes in government revenue. These methods predominate in virtually all of the comments in all of the dockets relating to spectrum sales. The key relevant feature of such methods is an assumption that a change in the amount paid when a public resource is privatized is a pure transfer, with no efficiency consequences.

That assumption is appropriate in the realms of "high theory," where lump-sum transfers can serve the public fisc. It is wholly inappropriate in an economy that relies on excise taxes, income taxes, and payroll taxes to support that part of its expenditures which are not covered by debt finance. Conclusions reached by such methods ought to be presented with serious caveats, and the authors know better than to blithely proceed without pause.

Eaton, *Microeconomic Theory*, 3rd Ed., 1996, Prentice-Hall; all calculations here follow exactly the steps in those chapters). To take one example, suppose an incumbent serves the two market niches adjacent to the intermediate market niche an entrant would find most profitable. Then the model implies that, to a close approximation, the affected incumbent is willing to pay about twice as much as the entrant in order to warehouse the WCS license that would otherwise be used to enter this intermediate market niche. This approximation is relatively unaffected by substantial changes in the total number of CMRS incumbents.

Notice that it implies the following. Suppose three WCS licenses are being offered in this MTA. Suppose the bidder with the highest value for one of the WCS licenses here intends some unrelated usage (e.g., DARS). Then, if this CMRS market exhibits even a slight first-mover advantage not captured by the address model, the affected incumbent is willing to purchase and warehouse *both* of the remaining licenses, and to pay slightly more for each of them than a potential entrant could afford to pay for either.

While these results do not cover every possible sort of competition in a concentrated industry, the fact that such diverse models all point to the same conclusion does create a natural presumption that a CMRS incumbent may often be willing to pay more to warehouse a license than the most a potential entrant to that market would be willing to pay.

[6] Most notably US West comments in docket WT 96-59, April 15, 1996.

11. Imagine that there is a change in auction procedures which the FCC could adopt that would result in a $1 billion increase in revenue. This change could allow the federal government to collect $1 billion less in taxes. All the taxes governments in the U.S. use distort behavior, as individuals and firms behavior change at least somewhat in an effort to reduce their tax liability. The result of these behavior distortions is that taxes cost the economy more than the revenue they collect.

Every reasonably well-trained economist has been exposed to the considerable literature attempting to estimate the size of this "excess burden" of taxation. Given the enormity of the task, and the frequency with which tax regulations are changed, it is unsurprising that the scholars working in this area have not reached a consensus.

Numbers proposed have ranged from 14% to 333%.[7] Virtually all of the scholars contributing to these studies would agree that 33% is a conservative estimate of the excess burden of federal taxation.

This implies that a $1 billion tax cut, or a $1 billion tax increase prevented, effectively makes Americans $1.33 billion richer. Subtract the extra $1 billion that winning bidders paid for the spectrum, and we find that the economy is better off by $0.33 billion dollars because of the extra revenue brought in by the FCC.[8]

The 33% efficiency gain from added auction revenue assumes that all the added auction revenue goes into tax relief. If some of it goes into debt reduction, our best estimates are that the efficiency gain is a much larger percentage.[9]

12. Some major telecommunications firms seem to deride small firms as necessarily inefficient users of spectrum (again the US West comments on the D, E, F block rulemaking are a prime example). This strikes me as highly presumptuous. In particular, I suspect that the presumption large firms make is that small firms will be unable to achieve capacity utilization rates which the large telecommunications firms attain. It bears observation that this is the presumption that AT&T made about MCI and Sprint in the 1980s.

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[7] These extremes come from Edgar Browning, *Journal of Political Economy*, 1976), and Martin Feldstein, "What the '93 Tax Increases Really Did," *The Wall Street Journal*, October 26, 1995, p. A22.

[8] Rest assured that no magic wand is being waved. At the level of individual transactions, here is what is happening. A worker who is in a 40% tax bracket would decline an offer to work overtime at $15 an hour if the leisure time that would be given up to work overtime is worth more than $9 an hour to her. Given the firm's offer of the overtime wage, we know that the value of the work that she considers whether the after-tax rate of return, 8.6%, is far enough above the return she is currently getting on $1 million invested in municipal bonds to justify the added risk.

Again, the economy faces this sort of choice a million times a day. In some cases, a 57% tax bracket drives the after-tax return low enough that it does not quite justify the added risk. Clearly, the funds are more valuably invested in the firm. A small reduction in tax rates can attain these efficiency gains for those cases for which the after-tax return came close to justifying the risk.

[9] Cf. Feldstein, *Journal of Public Economics*, 1986. However, Congress may not be able to resist added spending when the FCC auctions bring in $1 billion in added revenue. The sort of example a cynic might construct would have 70% of the added revenue go into some combination of debt and tax relief, 20% go into somewhat wasteful added spending that has a social value of $0.95 for each dollar spent, and 10% of the money completely wasted by Congress (i.e., with no social value whatsoever). Then if the particular combination of debt and tax relief happened to average and excess burden of 73%, which is not at all unreasonable, once again the overall effect of the added revenue is to yield a 33% efficiency gain.

There are two significant situations in which the presumption is likely fallacious. One is when large firms warehouse spectrum. For example, suppose a large firm holds 40 MHz of spectrum. There is some point past which added spectrum will not lead to an added effective capacity which could attract more customers. While I suspect it is lower, assume for the sake of discussion that this point is at 30 MHz. If this large firm and a small firm holding 10 MHz of spectrum are correspondingly adept at attracting and keeping customers, the large firm will then have three times the small firm's market share. If the large firm has brand-name cachet or other inimitable marketing and customer service advantages, it may attain more than three times the small firm's market share. But it has to go past four times to be a more efficient user of spectrums.

The second situation arises when the small firm applies spectrum to a new and innovative use. Probably, it is initially a monopoly supplier of the new service, and will continue to enjoy a first-mover advantage after competitive firms supply a very similar service. Again I would consider the number to be high, but suppose that effective capacity for serving the entire CMRS market is 105 MHz. In most major urban areas, by the completion of the D, E, F block auctions, there will be on the order of 210 MHz capacity among the large firms supplying CMRS.

A small firm acquiring 10 MHz for an innovative usage need only reach the point where 5 MHz would be inadequate to be a *more efficient* user of spectrums.

13. Nonetheless, grant the large firms their questionable presumption: suppose small firms are less efficient users of spectrum. It can nonetheless make clear economic sense to offer small firms bidding credits. There can be no doubt that small firms, efficient users of spectrum or not, are disadvantaged competitors in bidding for spectrum. It is sufficient to realize that network buildout will be financed by small firms at a much higher cost of capital to conclude they are disadvantaged.

A first-line bidder (a large firm) facing at most a couple other first-line bidders and otherwise disadvantaged competitors rationally takes advantage of this. On average, the price he pays for a license won is lower than if all of his competitors had as low a cost of capital as he has.

If small firms are given bidding credits, this reduces their disadvantages somewhat, making them more effective competitors. In the auction form used so far, whenever a small firm is able, due to bidding credits, to compete to a higher gross bid than all but one of the first-line bidders, the bidding credits have served to increase the price paid by the winner.

This understates the likely revenue gains from large firms facing disadvantaged bidders who are subsidized. Competitive gross bids by small firms also make large firms switch the licenses they bid on. The effect is to make a given number of large firms compete against each other on a larger set of licenses.

14. The Regional Narrowband auction in 1994 provides an illuminating example. Designated bidders were given preferential treatment on all bands, including larger preferences on bands 2 and 6. Ayres and Cramton[10] analyze these auction round-by-round. They find a compelling case that designated bidders were able, because of bidding credits and installment payments, to compete against eventual winners past the prices where the final losing first-line bidder on particular licenses ceased competing. Ayres and Cramton use this information to calculate a

[10] Ian Ayres and Peter Cramton [1996], "Deficit Reduction Through Diversity: How Affirmative Action At the FCC Increased Auction Competition," *Stanford Law Review*, 48, 401-53.

lower bound on the total added revenue the FCC obtained as a result of designated bidders driving up prices on licenses first-line bidders won. This added revenue more than paid for the subsidies and preferential loan arrangements on licenses designated bidders won.

15. Ayres and Cramton do not resolve the question of whether the bidding credits led to a more efficient outcome in the Regional Narrowband auction. To do this would require information on the extent of inefficiencies (if any) in spectrum usage as a result of awarding several licenses to designated bidders. This data is not available, and may never be.

A full efficiency calculation can be performed in the theoretical model of Rothkopf, Harstad and Fu (below, "RHF"), for the simple auction (by sealed bidding) of a single contract.[11] Their model is presented in the context of bidding by potential sellers for a contract to supply a single product or service, such as construction of a public building. The results fully carry over to an auction context where bidders are seeking to buy an asset, the context I will use in describing their results.

The RHF model assumes, quite legitimately, that no bidder knows for certain what the license's value in use will be. To make the analysis tractable, it assumes that whatever the license value turns out to be, it will be the same for every first-line bidder; for every designated bidder, license value will be some D% less than its worth to a first-line bidder (e.g., 25% less). All bidders are assumed to know D. Each bidder conducts its own market analysis to arrive at an estimate of license value. To focus on differences in value-in-use across the bidder types, rather than in market analysis accuracy, RHF consider the case where no bidder is systematically more accurate than others in its market analyses.[12]

Impact of bidding credits naturally depends on how many first-line and how many designated bidders compete, on how severe the designated bidders' disadvantage is, and on how accurately bidders' market analyses predict license values. Only for values of these parameters that seem to be quite far-fetched do bidding credits generate net inefficiencies when 33% of added revenue constitutes an efficiency gain (the benchmark for all of RHF's analysis).

Granting bidding credits leads first-line bidders to respond by bidding more aggressively whenever designated bidders have a chance of winning. For an extremely wide class of parameter values, bidding credits pay for themselves, in that the cost of bidding credits (i.e., the difference between gross bids and net bids in the event a designated bidder wins) is less than the added revenue due to more aggressive bidding by first-line bidders. For almost as large a class of parameter values, this excess of added revenues from first-line bidders beyond that needed to cover bidding credit costs remains more than 3 times the monetary size of the inefficiencies that result from awarding the license to the lower-valuing designated bidder some fraction of the time. In other words, the 33% of net added revenue that represents an *efficiency gain* is not only positive, but *greater than the allocative inefficiency cost.*

This allocative efficiency cost, the lower value of a license if won by a designated bidder, can be expressed as P*V*D, where P is the probability that a designated bidder wins, V the expected license value to a first-line bidder, and D (as before) the percentage by which the

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[11] Michael H. Rothkopf, Ronald M. Harstad and Yuhong Fu, "Is Subsidizing Inefficient Bidders Actually Costly?" unpublished, RUTCOR Research Report, Rutgers University, September 1996.

[12] Two further restrictions allow RHF to calculate equilibrium impacts of bidding credits: that estimating errors have extreme-value distributions, and that bidders choose bidding markdowns that produce bids proportional to their license value estimates.

license value is lower for a designated bidder.[13] Given a higher cost of capital, a small firm granted a sizable bidding credit can still only afford to submit a gross bid higher than that of a large firm if the small firm's use of spectrum will be at least nearly as efficient as the large firm's use.[14]

These findings were for sealed bidding, but they remain relevant to multi-stage progressive bidding. The reason that first-line bidders choose to bid more aggressively when disadvantaged bidders are given bidding credits is simply that the first-line bidders want to lose to designated bidders only rarely, and the bidding credits lead the designated bidders to make higher gross bids. It is precisely these higher gross bids that lead to higher revenue in multi-stage progressive bidding.

The import of RHF's findings is that on the issue of bidding credits, two Congressionally mandated objectives, "... avoiding excessive concentration of licenses and ... disseminating license among a wide variety of applicants..." and "efficient and intensive use of the electromagnetic spectrum," are in accord. In all likelihood, *attempting an efficient outcome requires the FCC to use bidding credits.*

16. The suggestion by US West and others that small firms' purpose in entering FCC auctions is pure speculation flies in the face of common sense, especially for the WCS auctions. The thousands of hours and tens, perhaps hundreds of thousands of dollars that must be spent to compete in the WCS auctions could easily be avoided, if one's purpose were to speculate on increased prices of spectrum in the future. The expedient way to speculate would simply be to make an equity investment in a small firm that wins some D, E, and F block licenses. Such firms will be looking for financing to cover buildout costs. Moreover, it would be irrational to assume that this round of WCS auctions is to be the last round of broadband privatization.

Part II: Implications for WCS Rules

In this part, I outline the practical conclusions of an appropriate understanding of efficiency for the rules the FCC should adopt in WCS auctions.

17. Given that bidding credits used in part to fight warehousing are likely to increase WCS auction revenue, warehousing of spectrum is contrary to all four of the objectives Congress has mandated. Among envisionable uses of spectrum, warehousing is the least efficient and most anti-competitive. Naturally, then, fighting warehousing and resisting the lobbying of CMRS incumbents in implicit support of warehousing ought to be the FCC's highest priority.

18. Full capacity for a CMRS provider is by industry consensus somewhere far below 45 MHz. Accordingly, removing the 45 MHz cap can only serve to further warehousing, and is

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[13] None of these three terms can be precisely known in the real world, but they can be specified in the model.

[14] As mentioned, the nature of the tradeoff varies with the probabilities; those interested in the particulars should contact the authors for details. At a very rough level, the most efficient subsidy level is often at or slightly above half of D, the percentage disadvantage. If efficiency were the sole consideration, only for strikingly low estimating errors would it pay to subsidize designated bidders so sharply that they can participate on at least an even footing with first-line bidders. But even when the government has poor information about how extensive designated bidders' disadvantage is, a somewhat cautious policy of granting bidding credits is preferable on efficiency grounds to granting no bidding credits at all.

contrary to all four Congressional objectives. Indeed, the FCC needs to consider seriously what it can do to keep firms from approaching the 45 MHz cap.

19. It makes sense to fight warehousing by placing CMRS incumbents at a disadvantage in the bidding in the particular MTAs where they hold spectrum. A simple and minimal way to do this would be to provide a 5% bidding credit on a particular license to any bidder who had no radio spectrum holdings at all in the geographic area covered by the license.

20. New and innovative uses of spectrum may prove to be economically viable at first only in particular regions of the country with the most favorable demographics for the planned uses. Moreover, at this stage, the firms attempting such innovative introductions may find it hard to raise the needed funding to compete for regional licenses. This suggests that licenses ought to be offered for as fine a partitioning of the US as possible, to support such potentially innovative uses of spectrum. The FCC's stated constraint of 306 licenses is eminently reasonable given the time constraint, and the apparent impact of BTA partitioning in slowing down the C and the D, E, and F block auctions. Consistent with this constraint and the objectives would be selling three sets of paired 5-MHz channels in each MTA, 153 licenses in all.

21. A very small number of participants won a sizable fraction of all licenses in the A and B block auction, and again in the C block. Overall, the ratio of the number of firms winning at least one license to the number of licenses has been small, and smaller for MTA auctions than for BTA. The FCC will only have to handle a relatively small number of wire transfers for down payments and for final payments if these 153 licenses are sold.

22. It is easy to underestimate the extent to which small firms are at a disadvantage. Assuming that the purpose of bidding is not to warehouse but to supply communications services, a bidder acquiring a license will face substantial investment in acquisition of capital equipment and of site usage permissions, and costs of equipment placement and testing. Before we know what the WCS licenses will cost, and what uses winners are planning, any estimates of the ratio of license cost to buildout cost must be so vague as to be near foolhardiness. Let us simply work with the estimate that this ratio is 1-to-1.

Then for a firm to carry out its plans, it must come up with funds for upfront payments quickly, funds to cover the total cost of the licenses rather quickly, and funds to build out rapidly enough to get into the market and begin bringing in some revenue. As US West points out, the cost of the capital to do all this for a blue chip firm may be about 7%, and may be about 8% for a firm whose bond offerings will be rated investment grade, while a small firm may face an 18% cost of capital. These numbers change with financial market conditions, but their ratio changes rather little. Of course, due to compound interest, the ratio of the payments firms of different financial strength will have to make, to amortize debts of similar size over similar holding periods, substantially exacerbates differences in costs of capital.

23. In the C block auctions, net bids were 75% of gross bids. However, under reasonable assumptions about Treasury interest rates and costs of capital, the present value of net bids (under payment plan C) was from 50% to 55% of net bids, which translates to 40-44% of gross bids. That is, the installment payment terms which presumably cannot be extended to small firms in WCS auctions were more valuable to their C block recipients than were the bidding credits. So bidding credits that are no larger than 25% will ameliorate competitiveness disadvantages small firms face by less than half as much as the extent of assistance provided small firms in the C block auctions. While this does not make a compelling case for exactly

the same standards, recall that the 40% bidding credits plus installment terms used in the Regional Narrowband auction have actually been shown to have put more money in the Treasury.

24. If the very nature of opening up auctions to bidders exploring new and innovative uses of spectrum is that the bidders have better information about how spectrum will be used in their planned applications than do other bidders or the FCC, it stands to reason that maintaining flexibility ought to govern the type of licenses offered.

25. In particular, bidders seeking to develop communications services with low-tier microcellular technology, such as PACS, need paired channels, for which 5 MHz each is a sensible bandwidth. A reason why more attention should be paid to these users than the typical applicant is the large gains in efficiency and competitiveness that could result from PACS or similar competition with an LEC. Also, pairing 5 MHz channels is a way to fight warehousing: if licenses were simply offered in unrelated 5 MHz groupings, a CMRS incumbent would be able to forestall a low-tier microcellular technology bidder, such as a PACS bidder, on 10 MHz while only incurring the cost of buying 5 MHz.

26. Similar to point 31, without knowing what technologies bidders select when being encouraged to introduce various technologies, any buildout requirement might be a requirement that we would choose not to impose on a particular technology. Specifying that there will be no buildout requirements is a way of accommodating them all.

27. With less usage of spectrum in rural than urban areas, there is no need for all rural areas to be served on all spectrum blocks.

Part III: Auction Form

I consider here the questions of whether the FCC should consider other auction forms for this WCS auction, and whether the FCC can be sure it can bring a multi-stage progressive auction to a timely conclusion.

28. It borders on the foolhardy to consider significant changes in the auction form given the time pressure. As this part indicates, the FCC can control auction speed so as to reach completion on time without opening up to significant inefficiencies. I do not consider license-specific bidding credits or a few permitted combinational bids significant changes in auction form, though they may be significant changes in the rules.

29. Alternatives are fraught with danger, of at least political embarrassement (which has definite economic consequences), and are rash given the circumstances. The simultaneous, multi-stage progressive auction was outlined in main detail by Paul Milgrom and Robert Wilson about 8 (narrowband) to 14 (broadband) months before its use, with activity rules described about 6 (narrowband) to 12 (broadband) months before use. Many details were widely debated in a relatively unhastened atmosphere. Moreover, the known alternatives to the proposed auction all had known, serious disadvantages.

Of course, it cannot be said that alternatives to an open outcry auction, or to continuous-time bidding all have known, serious disadvantages; the simultaneous, multi-stage progressive auction is an exception. Moreover, only a tiny fraction of the time for analysis is available, and at most a small subset of the auction theorists engaged for analysis then will be engaged now. Also, there is no clear analysis that implies an open outcry auction, or continuous-time

bidding with discrete pauses, actually promises to bring the auction efficiently to a speedier conclusion. Much of the time needed to run the auction currently, under the simultaneous, multi-stage progressive form, is time that is needed either to provide bidders feedback about prices, or to allow the bidders to use that information to revalue licenses and strategies. Which of these purposes do supporters of an alternative think are so unimportant that time ought not be allowed for that purpose?

30. The number of licenses, bidders, and rounds are likely to be less than the D, E, and F block auction. I am not worried about finishing on time: The FCC has three rather efficient weapons to hasten conclusion without raising significant inefficiency concerns. The first is to increase the number of rounds per day, boldly and inexorably. The FCC has heretofore given in all to readily to objections to more rounds per day, as if not noticing the poverty of the arguments objectors raise. Too little attention has been given to how well this strategy worked in the National Narrowband auctions.

I argue the following schedule is without logically compelling defects:

On day:		At round:	Begin this number of rounds per day:
4	4	2	
9	14	3	
12	23	4	
15	35	5	
18	50	6	
23	80	7	
28	115	8	
38	195	10	

where only business days are counted. This schedule fits 100 rounds into 5 weeks, 178 into 7 weeks (not counting holidays). This schedule may look egregious to some, but notice that it can be relaxed some and still fit within the FCC's time line. (Whatever actual schedule the FCC puts out may be more widely accepted if compared with this proposal.) Also realize that the lower parts of the schedule are not expected to be reached; the auction should be over before then.

Complaints to any sensible schedule can safely be predicted, but they will largely be emotional and unresponsive to the Congressionally mandated revenue deposit deadline. The key to the schedule's success is to use its relentlessness to induce bidders to simplify their goals and strategies, and promptly indicate their willingness to outbid rivals for those licenses which are key to them. A haphazard schedule of increases in rounds per day, soliciting comments every time the FCC tentatively proposes more rounds, has all the wrong incentives. Indeed, it is critical that the FCC announce the schedule at least three steps at a time, as in "We shall proceed to 4 rounds per day at round 23, 5 rounds per day at round 35, and 6 rounds per day at round 50." It must mean it: any objection raised that are deemed worth paying attention to can affect when the FCC goes to 7 rounds per day, but not to the decision already announced.

Similarly, the details of the associated daily schedule should be announced three steps in advance, and should appear unrelenting, both shortening bid submission periods and bid withdrawal periods (with few new bids expected, submission periods can eventually be cut to

15 minutes or considerably less, withdrawal periods to 5 minutes), and unrelentingly increasing the length of the auction day as well.[15] Sleep deprivation can work wonders.

31. The second weapon is minimum bid increments, which were quite effective in the Regional Narrowband auction, even more effective in the National Narrowband auction, and have been set less and less effectively as the Broadband auctions have proceeded. Minimum opening bids need to return, perhaps at $0.01 per MHz-pop (even slightly higher, perhaps). If some licenses had gone rounds with no bids at all, the minimum opening bid could be reduced; however, such reductions should appear so infrequent and random that a bidder has no reason to delay tendering an initial bid hoping for a further minimum bid reduction.

The serious problem in the D, E and F block auction, though, has been with how low bid increments have been when the initial bid on a license was trivial and there was further activity in that BTA. It is critical to keep huge minimum bid increments on licenses with extremely low prices, 100% or even 400%, at least until stage transition decisions appear. Auto auctioneers have long known that bid increments at the end of an auction limit inefficiencies and lost revenue, and may need to be small, but that a larger bid increment earlier in an auction, if it can be used, brings the price into line much faster without creating significant chances for large inefficiencies. Indeed, on any license with 3 or more new bids, a 40% bid increment can be used for at least the following round, quickly decreased thereafter if it prevented all new bids on that license.

32. The third weapon is a new system for ending the auction without the nearly unlimited inefficiencies introduced by announcing a final round that effectively converts to a first-price auction.

Suppose the FCC decides before round T that they wish to bring the auction to an orderly end. The following twelve-round ending procedure would be invoked. That it might be invoked, and how it would work if invoked, would be announced to the bidders before the auction began. It involves the following steps:

A. The FCC announces before round T begins that round T will be the *last* opportunity for bidders to submit a bid which *exceeds* the minimum bid on a license. If the FCC has not already done so, it announces a very large number of rounds per day (say, 10), justified by the fact that bids in later rounds do not involve a decision of how much to bid, but merely whether to bid on any license. Bidders are reminded that ties (which will now become more numerous) will continued to be broken by time of bid receipt.

B. At the same time, the FCC announces that it will be closing markets with three consecutive rounds of no new bids, first doing this in round T+4, and every round thereafter. (Simultaneous closing has some efficiency advantages, but at some point they must be sacrificed if auction completion is critical. The potential inefficiencies associated with this closing rule are quite small compared to a single final round.)

C. Before round T+2, the FCC announces two rule changes that will take effect beginning with round T+6. First, any bidder will have a new option for any license for which it is the standing high bidder, called a Contingent Raise. The effect of a Contingent Raise will be to enter a bid by that bidder at the minimum bid if any other bidder submits a legal bid for the license, otherwise to leave the current high bid standing. The bid entered on the bidder's behalf, if used, will be regarded as received at the same time the FCC receives the Contingent

[15] This works best if every time rounds are added, West Coast bidders can see their day starting earlier and East Coast bidders can see their day ending later.

Bid instruction, and thus will have the same standing for tie-breaking. Second, a bidder with a standing high bid in a market no longer gets to count that bid for eligibility calculations; only new bids and Contingent bids preserve eligibility.

D. During these rounds, a sizable bid increment is used in any market with 3 bids, and an even larger bid increment in markets with 4 or more bids.

E. The FCC announces at least 6 rounds in advance that round F will be the final round. Round F is at least 12 rounds after round T, when this process was invoked. Note that in round F, a standing high bidder on a license submits either no bid or a Contingent Bid; any other bidder submits either no bid, or a bid at the minimum bid increment. Minimum bid increments are set lower than in the previous round. The tie-breaking rule determines the final winners on any license drawing more than a single bid.

The notion behind the Procedure is that ultimately demand is most simply reduced to supply by imitating a Walrasian auctioneer. If demand cannot be fully reduced rapidly enough, rationing is used (via tie-breaking). Since opportunities to bid as much as bidders wanted have not succeeded in removing excess demand, such opportunities will be given only once more. The Procedure works best if the FCC sets fairly high bid increments during all rounds after T but before F, relying on rationing as little as possible. The remaining inefficiencies associated with round F tie-breaking are likely minimal, but the most important aspects of the Procedure are [i] it ends, within little more than a day, [ii] it deliberately chooses to sacrifice the revenue that a final first-price round might achieve to prevent the inefficiencies such a round would entail, and [iii] it ends.

Part IV: Time Pressure

Finally, I point out why the most critical time constraint is the need to give bidders time after rules are set to get their financial resources in place.

33. It is critical to have a significant time after rules are finalized before upfront payments are due; I call this time frame the "business-planning" period. There can be little doubt that a significant portion of the difference between C block and D, E, and F block prices is due to the astonishing FCC decision to require upfront payments for the latter auction only 7 weeks after announcing rules that doubled downpayments and quadrupled upfront payments. (That rash action makes one queasy about how the FCC will respond to explicit Congressional time pressure. It is as if the care that went into conducting Narrowband, A/B, and C auctions were deemed no longer important.)

Haste, in terms of too little business-planning time, creates difficulties not solely in lost revenue—fairness and efficiency suffer as well. That is, particular potential bidders are the ones effectively shut out of the bidding by such rash decisions. Those shut out are disproportionately firms seeking to obtain outside backers, most especially those who seek to convince outside backers to support plans to obtain funding for new and different technologies. Any firm seeking outside support must re-prepare its business plan after changes such as those announced for the D, E, and F block, and begin afresh its pitch to potential backers. The less mainstream the business plan, the more details that must be re-worked, and the more time backers must have if they are to decide sensibly.

That FCC decision to allow only 7 weeks for business-planning, in my opinion, amounted to an unambiguous violation of clearly stated Congressional instructions to include

small businesses and new technologies. The FCC was instructed to provide some diversity in licensing and avoid excessive concentration in licenses, which is hardly possible if they are barred from competing. The tight Congressional time schedule should be viewed as reinforcing those instructions. Repeating a business-planning time frame under 90-100 days would amount to twice deciding to bar these firms. Should the firms twice barred then seek an injunction, they may well find Congressmen willing to offer *amicus curiae* support.

34. Of course, the FCC has no need for such a short business-planning period to stay within the Congressional time frame. For one thing, its wholly appropriate plan to allow only wire transfers for payments means round 1 can begin on the afternoon of the third business day after the upfront payments deadline, and winners' wire payments can be processed much more quickly as well. Secondly, it is completely sensible to make April 15 the short-form submission deadline, April 29 the upfront payments deadline, begin round 1 on May 2, and declare that the Congressional deadline for starting the auction has been met.

Appendix I

This Appendix provides calculations supporting the claim that a firm using low-tier microcellular technology, such as PACS, entering a local exchange market has a far greater impact on market concentration than either [i] a new entrant into cellular/PCS competition, or [ii] enhancing the capacity of current players in the cellular/PCS market.

Consider a market with 1,000,000 subscribers, for convenience of calculations. Consider *Scenario A*: the LEC's only competition is 3 one-stop shopping firms, to whom it resells local connections. Let the three resellers have 35,000, 30,000, and 25,000 subscribers; suppose 20% of each reseller's customers have wireless service. Then the Herfindahl-Hirschman Index (HHI), based solely on subscribers, is:

Firm	Market Share	HHI
LEC	91.00	8,281.00
Rslr 1	3.50	12.25
Rslr 2	3.00	9.00
Rslr 3	2.50	6.25
Subscribers-Based HHI:	100.00	8,308.50

However, this calculation ignores the fact that the LEC has nonnegligible control over the resellers' costs, and hence their prices. An HHI based upon receipt of access charges would show:

Firm	Market Share	HHI
LEC	98.20	9,643.24
Rslr 1	0.70	0.49
Rslr 2	0.60	0.36
Rslr 3	0.50	0.25
Access-Based HHI:	100.00	9,644.34

Clearly both subscriber-based and access-based measures provide useful information. To combine them, I simply use the average: the combined HHI for Scenario A is 8,642.46.

Scenario B: A firm using low-tier microcellular technology (called PACS entrant below), enters and competes with the LEC and the three resellers. Let the PACS entrant be conservatively assumed to obtain 4% of the customers of each reseller, and 9% of the customers of the LEC; an argument why this is a reasonably conservative assumption follows the calculations. Continue to assume that 20% of each reseller's customers have wireless service.

Firm	Market Share	HHI
LEC	82.81	6,857.50
PACS	8.55	73.10
Rslr 1	3.36	11.29
Rslr 2	2.88	8.29
Rslr 3	2.40	5.76
Subscribers-Based HHI:	100.00	6,955.94

Next, suppose that the access charge the PACS pays to the LEC each time a PACS-originated call terminates at an LEC connection is equal to the access charge the LEC pays to the PACS each time an LEC-originated call terminates at a PACS connection. Also suppose that call originations and call terminations have uncorrelated distributions. Then an HHI based upon receipt of access charges would show:

Firm	Market Share	HHI
LEC	89.72	8,050.04
PACS	8.55	73.10
Rslr 1	0.67	0.45
Rslr 2	0.58	0.33
Rslr 3	0.48	0.23
Access-Based HHI:	100.00	8,124.15

The combined HHI is now 7,248.00, a substantial reduction in market concentration. Yet scenario B is a conservative estimate of the gains from PACS entry into a local exchange market.

Scenarios C-G consider potential impacts of WCS licenses being used for entry (low- or high-tier) or added capacity in CMRS markets, using the sort of capacity-based HHI calculations the FCC used to support maintaining the 45 MHz spectrum cap for the D, E, and F block auctions. Each scenario is presented with two sets of capacity numbers. The first set comes from the capacity situation in New York, the second from Los Angeles; each assumes that the high bidders as of round 135 in the D, E, and F block auction end up winning.

*Scenario C*1, before the WCS auction:

Firm	MHz	Market Share	HHI
Cellular A	35	20.59	423.88
Cellular B	25	14.71	216.26
PCS A	40	23.53	553.63
PCS B	30	17.65	311.42
PCS C	30	17.65	311.42
Big SMR	10	5.88	34.60
Total	170	100.00	1,851.21

*Scenario D*1, which adds a single-license WCS holder:

Firm	MHz	Market Share	HHI
Cellular A	35	19.44	378.09
Cellular B	25	13.89	192.90
PCS A	40	22.22	493.83
PCS B	30	16.67	277.78
PCS C	30	16.67	277.78
WCS	10	5.56	30.86
Big SMR	10	5.56	30.86
Total	180	100.00	1,682.10

*Scenario E*1 instead assumes that WCS licenses go to the largest capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	45	22.50	506.25
Cellular B	35	17.50	306.25
PCS A	40	20.00	400.00
PCS B	40	20.00	400.00
PCS C	30	15.00	225.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,862.50

*Scenario F*1 has WCS licenses going to lower capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	35	17.50	306.25
Cellular B	35	17.50	306.25
PCS A	40	20.00	400.00
PCS B	40	20.00	400.00
PCS C	40	20.00	400.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,837.50

Scenario G1 assumes that WCS licenses go to some of the largest capacity holders in the market, and assumes the 45 MHz spectrum cap is removed:

Firm	MHz	Market Share	HHI
Cellular A	45	22.50	506.25
Cellular B	25	12.50	156.25
PCS A	50	25.00	625.00
PCS B	40	20.00	400.00
PCS C	30	15.00	225.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,937.50

Next we repeat the same scenarios, but base the capacities on the initially less concentrated market in Los Angeles. *Scenario C2*, before the WCS auction:

Firm	MHz	Market Share	HHI
Cellular A	35	19.44	378.09
Cellular B	25	13.89	192.90
PCS A	30	16.67	277.78
PCS B	30	16.67	277.78
PCS C	30	16.67	277.78
PCS D	20	11.11	123.46
Big SMR	10	5.56	30.86
Total	180	100.00	1,558.64

Scenario D2, which adds a single-license WCS holder:

Firm	MHz	Market Share	HHI
Cellular A	35	18.42	339.34
Cellular B	25	13.16	173.13
PCS A	30	15.79	249.31
PCS B	30	15.79	249.31
PCS C	30	15.79	249.31
PCS D	20	10.53	110.80
WCS	10	5.26	27.70
Big SMR	10	5.26	27.70
Total	190	100.00	1,426.59

Scenario E2, WCS licenses go to the largest capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	45	21.43	459.18
Cellular B	35	16.67	277.78
PCS A	40	19.05	362.81
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	20	9.52	90.70
Big SMR	10	4.76	22.68
Total	210	100.00	1,621.32

Scenario F2, WCS licenses going to lower capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	35	16.67	277.78
Cellular B	35	16.67	277.78
PCS A	40	19.05	362.81
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	30	14.29	204.08
Big SMR	10		22.68
Total	210	100.00	1,553.29

Scenario G2, WCS licenses go to some of the largest capacity holders in the market, and the 45 MHz spectrum cap is removed:

Firm	MHz	Market Share	HHI
Cellular A	50	23.81	566.89
Cellular B	25	11.90	141.72
PCS A	45	21.43	459.18
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	20	9.52	90.70
Big SMR	10	4.76	22.68
Total	210	100.00	1,689.34

Finally, the HHIs calculated are combined in the last table. To evaluate these changes in the HHI, some social welfare measure is needed which incorporates the notion that a reduction in market concentration is more important in a more concentrated market (that is, for example, reducing the HHI from 6,000 to 5,000 is a more important impact than reducing from 3,000 to 2,000). Here I have used the formula SWG = [HHI1]^1.5 - [HHI2]^1.5 to produce the approximations shown in the Social Welfare Gain column. This column does not reflect another aspect that ought to be considered, the size of the market. Presumably a given reduction in the HHI is more important in a larger market.

Impact of WCS:	Changes HHI: From:	To:	Social Welfare Gain:
PACS entrant faces LEC:	8,976.42	7,540.05	1,957.33
NY Scenarios:			
WCS entrant in CMRS:	1,851.21	1,682.10	106.61
Add capacity, w/cap, bad:	1,851.21	1,862.50	-7.30
Add capacity, w/cap, better:	1,851.21	1,837.50	8.83
Add capacity, remove cap:	1,851.21	1,937.50	-56.33
LA Scenarios:			
WCS entrant in CMRS:	1,558.64	1,426.59	76.52
Add capacity, w/cap, bad:	1,558.64	1,621.32	-37.49
Add capacity, w/cap, better:	1,558.64	1,553.29	3.17
Add capacity, remove cap:	1,558.64	1,689.34	-79.00

In conclusion, entry of a low-tier microcellular competitor in a local exchange market has market concentration benefits that are about 18 times as important as the benefits of a WCS entrant into a CMRS market (as concentrated as New York) of the same market size, or about 90 times as important if the local exchange market is 5 times as large as the CMRS market. In a less concentrated market like Los Angeles, LEC competition is over 25 times as important, 125 times given differential market size. All the other scenarios fare even worse; even when capacity is added to less large firms (scenario F), the impact is a tiny fraction (1/200 to 1/3,000) of the gain via competing with a LEC.

Auction policies which foster opportunities for a low-tier microcellular provider, such as a PACS provider, to compete with a LEC have huge pro-competitive advantages, likely outweighing arguments for alternative policies.

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